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Abstract

FABRICATION AND IRRADIATION STUDIES OF UO_2-STAINLESS STEEL AND $(U,Pu)O_2$-STAINLESS STEEL CERMETS

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Studies of cermet fuels, which have been carried out by the U.K.A.E.A. during the past three years, have been concerned primarily with the development of pin and plate fuel elements for possible application in a fast reactor. For this application the oxide should be present in the concentration range 30 to 50 volume %, distributed in such a way that structural weakening of the matrix by fission fragment damage is minimized.

The matrix and cladding materials selected for the bulk of the work were A.I.S.I. Type 316L steels whose compositions were closely controlled to obtain maximum microstructural stability combined with good creep strength and ductility.

Hot swaging techniques were selected for the preparation of pins since these provide uniform compression in a fairly simple manner. Initial efforts were successful in eliminating the "stringering" normally found in cermet fuels but improvements were required as far as matrix densification, ceramic distribution

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and matrix-to-clad bonding were concerned. A technique was successfully developed to remove these defects; spherical granules of oxide were coated with steel powder, consolidated and sintered, and finally densified and bonded at a high temperature in a multi-die swage.

Hot-rolling, by a modification of the "picture-frame" technique normally used to make cermet plates, led to the preparation of dense, bonded plates with fairly uniform ceramic distributions. These plates were subjected to extensive mechanical, thermal and non-destructive tests.

Specimens of pins and plates prepared in the early stages of the fabrication development have been irradiated in thermal fluxes in the PLUTO reactor at Harwell and in the Dounreay Materials Testing Reactor and subjected to post-irradiation examination, while specimens with improved structures are still being irradiated. Encouraging performances have been obtained from pins with better initial structures.

Plate specimens with non-uniform ceramic particle distributions achieved 5% burn-up at 650°C surface temperature without failure but swelling was apparent beyond 7% burn-up.

The results suggest that the optimum irradiation performance may be achieved by careful control of granule composition and density, and of matrix density and permeability.